



CHAPTER 3 - AFFECTED ENVIRONMENT

This chapter describes physical, biological, and socioeconomic environments associated with the Refuge, the Castle Rock Watershed (Refuge Watershed), and the Yellow River Focus Area.

CHAPTER HIGHLIGHTS

- ! A Description of the History of the Refuge
- ! A Description of the Physical Environment
- ! A Description of the Biological Environment
- ! A Description of the Socioeconomic Environment

1. HISTORY OF THE REFUGE

European settlement occurred on the Refuge during the decade of 1850 to 1860. The first of a long history of fires probably occurred during the decade of 1860 to 1870 along with increased settlement and land clearing operations. By the early 1880s lumber operations were in full swing. This was followed in 1893 by a disastrous fire which eliminated most of the remaining tamarack and spruce in the bogs. This fire also burned into the peat, probably for the first time. Following this fire the country became very prairie-like, with a few scattered oak and pine on the "islands." The two prairie grouse, sharp-tailed grouse and prairie chickens, became abundant following this fire. Many of the former bog areas developed extensive stands of wire grass which were cut for commercial manufacture of carpets. Fires were common and widespread between 1893 and 1900.

Drainage and settlement proceeded in the decade of 1900-1910. In 1910 a fire burned large acreages of wild lands. Smartweed volunteered abundantly in crop fields and burns. By 1912 it was apparent that certain drainage ditches were inadequate, subjecting some fields to flooding. Drainage continued until about 1920, when the last drainage ditches were dug. Drainage had further reduced the tamarack and spruce areas and wire grass disappeared with elimination of surface water. It was replaced by farm weeds, goldenrod, bluejoint, woolgrass, sedges, willow, and increasing amounts of aspen and birch. Fire was common at this time. In 1920, a widespread fire covered much of the area.

Agriculture depression beginning in 1920, excessive drainage district taxes, and drought resulted in the end of the agriculture period. By 1925, abandonment was common, with only a few farms left. Most of the abandoned land was invaded by aspen, birch, woolgrass, and upland herbs.

In the fall of 1930 the most extensive and severe fire in the history of the area occurred. It burned more than 300,000 acres and consumed huge holes in the peat. Most of the sand islands were denuded of their topsoil, and it almost completely eradicated all indications of previous settlement. Following the fire, some areas came directly into aspen, while others came into agricultural weeds and smartweed.

Abandonment of most of the farms allowed for the creation of the Refuge in 1939. The events leading up to its establishment date back to the early 1930s when the U.S. Government acquired 114,964 acres of land in Juneau, Wood, Monroe, and Jackson counties, Wisconsin, using the

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authority of the National Industrial Recovery Act of 1933 and the Emergency Relief Appropriation Act of 1935. The purpose for these acquisitions was to assist farmers living within the area and to develop the area for wildlife.

Creation of the Refuge led to wildfire suppression and large scale wetland restoration activities by the Civilian Conservation Corps (CCC). Wetlands created by the CCC were actually not restorations as they created large, open-water impoundments where sedge meadows and tamarack bogs once occurred. Wildfire suppression activities had an equally significant effect as the areas prairie-like appearance began to disappear. Unsuppressed, succession began to create closed-canopy forests where they most likely had not occurred before. As the Refuge's savannas were lost, both prairie chickens and sharp-tailed grouse disappeared. By 1960, all of the Refuge's open-landscape savannas had been degraded. In that year, the Refuge began savanna restoration activities.

2. DESCRIPTION OF THE PHYSICAL ENVIRONMENT

2.1 Archaeological and Cultural Values

Archaeological records show evidence of human occupation in Juneau County since the end of the last Ice Age when Paleo Indians hunted large prehistoric animals. Every subsequent cultural period for the past 10,000 years is represented. The land now known as the Refuge was probably used by several cultures since the Ice Age. The peat-covered lowlands around the extensive marsh and shallow river environment contained a wide variety of food resources. Slightly higher ground would have been suitable for resource-extraction activities, but the people likely located their larger camps and villages on elevated land forms not found within the Refuge.

Archaeological investigations have covered 2 percent of the Refuge. The surveys and other sources have identified 27 prehistoric and historic sites. The earliest evidence of people on the Refuge has been dated to the Middle Archaic period of 5,000 to 3,000 years ago. The rest of the identified sites are camps from the Woodland period of 3,000 to 250 years ago, and farmsteads and cemeteries from the period of Western culture settlement and occupation. Prehistoric mounds, including effigy mounds, are reported near the Refuge. An inventory of Yellow River archaeological values and previous archaeological work within the Yellow River Focus Area has not been completed. As of November 1, 1998, the National Register of Historic Places contained seven properties in Juneau County and three properties in adjacent Jackson County. These properties include a bridge, houses, and prehistoric sites, including the Cranberry Creek Archaeological District 3 miles east of the Refuge.

Early 20th century fires burned across the Refuge area, destroying the peat so that now the sandy subsurface is exposed or shallowly covered with silt. The slight elevations that might have been used for resource extraction or temporary camps are virtually indistinguishable. In consultations with the Wisconsin State Historic Preservation Officer, the more efficient method of identifying archaeological sites would be to conduct a geomorphological investigation of the Refuge to determine where land forms exist that could have supported human use. The study conducted at Fort McCoy, Wisconsin, could be a useful prototype.



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Indian tribes may have interest in the Refuge area in terms of traditional cultural properties and sacred sites, as well as claims to human remains, funerary objects, and other cultural items. During the early historic period in Wisconsin, Indian tribes were in a great state of flux, many tribes from the east having moved from their ancestral land and pushed the aborigines from Wisconsin to the south and west. Thus, connecting historic period tribes with their prehistoric cultural antecedents in Wisconsin is problematic. People of the Late Woodland Lakes phases may have become the Menominee tribe. Evidence from archaeological excavations indicates that ancestors of the Winnebago had lived in eastern Wisconsin for hundreds of years; the Oneota of eastern Wisconsin may have been prehistoric Winnebago. In any event, historic records place Winnebago and Potawatomi in the area at the time of Western contact. The Refuge is within the area recognized by the Indian Claims Commission as being part of Menominee and Winnebago aboriginal territory. The Ioway spoke a Siouan language which likely links them to late prehistoric cultures of central and southern Wisconsin. To a limited extent the Illinois were indigenous tribes in southern Wisconsin, probably not as far north as the Refuge. By the 1600s, however, a variety of tribal groups were moving in and out of areas south of the Refuge and may have spent limited periods of time in areas adjacent to and within the vicinity. These tribes included the Sauk, Fox, Potawatomi, Kickapoo, Miami, and Mascouten.

2.2 Hydrology

Water plays an important part in the history of the Refuge. The sandy sediments and flat topography of the area are a result of Glacial Lake Wisconsin, a pre-historic lake that developed when a glacier blocked the Wisconsin River near Baraboo, Wisconsin. This extensive lake occupied large parts of Juneau and Adams counties, and parts of Wood, Portage, Waushara, Marquette, Columbia, Sauk, Richland, Vernon, Monroe and Jackson counties. Glacial Lake Wisconsin drained catastrophically about 13,000 years ago when the glaciers retreated.

The Refuge is located in the Upper Mississippi River/Tallgrass Prairie Ecosystem (Ecosystem) which is one of eight hydrologically defined ecosystems that comprise the Great Lakes-Big Rivers Region of the Service. The Ecosystem is a large and ecologically diverse area that encompasses land in the states of Wisconsin, Illinois, Indiana, Iowa, Minnesota, and Missouri. The Mississippi River bisects the Ecosystem east and west. Other major rivers include the Minnesota, Chippewa, Black, Wisconsin, Iowa, Rock, Skunk, Des Moines, and Illinois.

Located in the Castle Rock watershed (8-Digit Hydrologic Unit Code)(see Figure 5 and 6 in the CCP), the Refuge is supported by an important hydrological system comprised of natural and man-made waterways in which materials and energy are transferred. Some, such as the Yellow River and its tributaries, constitute an important ecological component to the Refuge by connecting biologically diverse food webs that provide important habitat features for wildlife. The Refuge, along with a series of other swampy basins such as Meadow Valley Flowage, Beaver Flowage, and numerous managed cranberry bogs, all contribute to the 7,800-square-mile Middle Wisconsin River Basin. The Castle Rock watershed drains 3,259 square miles, contains 27 rivers and streams, and has 3,358 total river miles.

On average, approximately 85 percent of the water entering the Refuge comes directly from precipitation, either as rain or snow (see Table 6). Precipitation averages 32.6 inches annually.

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Streams that flow into the Refuge contribute about 13 percent of the water, while groundwater flow into the Refuge accounts for about 2 percent of the water, due largely to the interception of ground water by the extensive drainage networks surrounding the Refuge. Surface-water inflow to the Refuge includes: Remington Ditch (60 percent), Neal Lateral (15 percent), EBR-Spencer (11 percent), Meadow Valley (6 percent), and un-gauged (8 percent).

TABLE 6 Summary of Water Sources and Sinks for the Refuge (May 1988 - April 1999)	
Water Sources	Annual Flow (acre-ft.)
Precipitation	118,700
Surface Water Inflow	19,600
Ground Water Inflow	2,300
Total Water In	140,600
Water Sinks	Annual Flow (acre-ft.)
Evapotranspiration Loss	85,400
Surface Water Outflow	51,500
Ground Water Outflow	2,700
Total Water Out	139,600
Change in Storage (water inflow - water outflow)	1,000
Percent of Water Inflow	0.7

U.S. Geological Survey Fact Sheet, May 2000

Of the water leaving the Refuge, about 62 percent is lost to evaporation from the pools or transpiration of water vapor back to the atmosphere from plants. Evaporation from open-water surfaces is estimated to be about 28 inches annually, as determined from a regional map of average annual lake evaporation (Kohler and others, 1959). Surface-water outflows from the Refuge, mostly through Rynearson Pools 1 (28 percent) and 2 (59 percent) and Suk-Cerney Pool (10 percent), constitute about 36 percent of the total outflows; groundwater flows out of the Refuge are about 2 percent of the total annual outflows. This small amount of groundwater outflow, along with larger surface water outflows, demonstrates the efficiency of the extensive drainage network within the Refuge boundaries. A natural topographic fall of 50 feet occurs from north to south across the Refuge, or roughly 2-3 feet per mile.

From recent groundwater modeling of the Refuge, annual recharge was estimated to be 9.5 inches. Hence, evapotranspiration was 32.6 inches (precipitation) minus 9.5 inches (groundwater recharge), or 23.1 inches. This value agrees well with the findings of Weeks and Strangland (1971), who reported evapotranspiration values for nearby agricultural areas ranging from 15 to 20 inches per year, with higher rates expected in areas containing water-tolerant vegetation. Groundwater moves through the Refuge in a northwest to southeast direction traveling toward the Yellow and Wisconsin Rivers. Groundwater varies from 0 to 20 feet and is typically high in iron,



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with a pH of approximately 6.0, which is slightly acidic. Total dissolved solids and hardness are low. Groundwater recharge occurs primarily from percolation of precipitation through the loamy sands.

Water control structures within the Refuge regulate drainage. Water contained within certain Refuge pools provide and impact water manipulation capability on other pools. Water is generally stored in Refuge pools during spring runoff and is used to refill pools that are drained and re-flooded during the course of the summer.

2.3 Physiography

The Refuge is located in the central plain province of Wisconsin within an area known as the Great Central Wisconsin Swamp, an extensive alluvial lake plain extending over 2,000 square miles. As stated previously, the Refuge is located in the Upper Mississippi River/Tallgrass Prairie Ecosystem (Service definition). Bailey's Ecological Unit Classification System (Keys et al., 1995) defines this ecosystem as laurentian mixed forest, eastern broadleaf forest, lower Mississippi riverine forest, and prairie parkland. The Refuge is located in the eastern broadleaf forest province within the central Wisconsin sand plain subsection.

Historic Situation

Historically, land in and around the Refuge was once a vast peat bog with some low wooded islands and savannas. The higher sand ridges were occupied by mature stands of pines and other species (see Figure 8 in CCP). The original land surveys of the area were conducted in 1853. While conducting the surveys, the surveyors recorded the soil quality, relief, and dominant timber types of the area. At nearly every survey point on the Refuge the land was described as "surface level, wet, and mostly swampy" with fairly open stands of "small, scattered "bastard pine" (jack pine) and tamarack." Notable exceptions to this were the sand ridges that cross the area. On these ridges the surveyors described the area as surface rolling with low ridges. The vegetation on these ridges was described as "scattered jack pine and black oak" (presumably Hill's oak). On occasion, white pine, red pine, birch, and aspen were mentioned at some survey points, but in limited numbers.

From this information it appears that the original landscape of the former lake bed of Glacial Lake Wisconsin, which the Refuge is part of, was wet and swampy and was dominated by jack pine and tamarack. This would be consistent with the name early pioneers gave to the area: "Great Central Wisconsin Swamp." Sand ridges provided diversity to this monotypic, wet landscape. On these ridges grew scattered patches of jack pine and Hill's oak. It is difficult to say exactly what habitat types were represented on these sandy areas. Based on the number of sessile savanna species that are found in the area today, these areas were most likely dominated by savanna habitat.

Current Situation

As of 1994, the Refuge consists of roughly 43,700 acres of pine, oak, and aspen forests, grasslands and savannas, and wetlands and open water areas, all of which support a rich diversity

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of fish and wildlife. Table 7 is a summary of land cover types on the Refuge. Table 8 is a summary of land cover types found in the Refuge watershed (for comparison purposes).

Refuge forest communities (upland) include northern mesic forest (white and red pine, bigtooth aspen, trembling aspen, red maple) and mixed wet-mesic forest (jack pine, northern pin oak, red maple, trembling aspen, paper birch). Refuge forests provide excellent habitat for many neotropical migratory birds such as the scarlet tanager, eastern wood-pewee, and ovenbird. Currently upland forests on the Refuge comprise roughly 16,500 acres.

Refuge grasslands, savannas, fallow fields, and shrublands comprise open landscapes on the Refuge. Refuge grasslands include prairies, fallow fields, and meadows. Tree cover on the grasslands ranges from little to none. Plant cover is a mixture of sedges, grasses, and forbs that attract nesting bobolinks, vesper sparrows, grasshopper sparrows, and upland sandpipers. Some common grassland species on the Refuge include big bluestem, little bluestem, Kentucky bluegrass, and a wide variety of other grasses, sedges and forbs. Blackberry and spirea are scattered in grassland areas as well. Willow-dogwood communities are invading old farm fields and wet meadows in places where disturbance is rare. Refuge grasslands provide important nesting habitat for many migratory birds including ducks, geese, and Sandhill cranes, and also serve as grazing sites for white-tailed deer.

Refuge savannas include northern pin oak, jack pine, warm season grasses, upland sedges, blueberry, goldenrod, and wild lupine. These savanna areas are also known as barrens, because fire and tree diseases such as oak wilt are more common in the droughty, sandy soils. These disturbances keep the trees small and scattered. Oak savanna has been defined as having at least one tree per acre, but less than 50 percent cover. Wisconsin historically had over 4 million acres of barren habitat covering 12 percent of the state. Today less than .14 percent remains. Refuge savannas support massasauga rattlesnakes, phlox moths, Blandings turtles, Karner blue butterflies, and over 110 species of birds. Currently, open landscape lands on the Refuge comprise roughly 3,700 acres.

Refuge wetlands include forested, non-forested, and open water wetlands. The majority of these occur within pools, streams, and ditches. Wetland plant species include pondweeds, spike rushes, elodea, coontail, milfoils, and duckweeds. Some Refuge pools are drawn down for part of the year to promote the production of high energy waterfowl foods such as millet, smartweed, chufa, beggar ticks, pigweed, sedges, and spikerush. Ditches and streams also provide additional wetland habitat, although to a lesser extent than Refuge pools.

Wet meadows and marsh edges consist of bur-reed, smartweeds, beggar's ticks, bulrushes, blue-joint grass, and reed canary grass. Open sedge meadows comprise mixed sedges with invading jack pine, willow, and hardhack. Sedge meadows on the Refuge are home to northern harriers, sedge wrens, and sora rails.

Bottomland forested areas include jack pine, silver and red maple, green ash, northern pin and swamp white oak, river birch, and trembling aspen. Tamarack was historically present in these areas. Currently non-forested, forested, and open water wetlands comprise roughly 23,500 acres.



TABLE 7 Land Cover Types in the Refuge	
Land Cover Type	Acres
Open Landscapes (grasslands, savanna, shrublands, old fields)	3,700 acres
Coniferous Forests	900 acres
Mixed Deciduous and Coniferous Forests	10,000 acres
Broad-leaf Deciduous Forests	5,600 acres
Emergent Wetlands and Wet Meadows	10,500 acres
Forested Wetlands	5,700 acres
Lowland Shrubs	5,500 acres
Open Water Areas	1,800 acres
TOTAL	43,700 ACRES

Data Source - WISCLAND (1994)

TABLE 8 Land Cover Types in the Refuge Watershed	
Land Cover Type	Acres
Urban Areas	26,565 acres
Agricultural Land	510,395 acres
Open Landscapes (grasslands, savanna, shrublands, old fields)	327,305 acres
Coniferous Forests	118,188 acres
Mixed Deciduous and Coniferous Forests	163,507 acres
Broad-leaf Deciduous Forests	431,145 acres
Emergent Wetlands and Wet Meadows	128,974 acres
Forested Wetlands	176,491 acres
Lowland Shrubs	108,187 acres
Open Water Areas	79,426 acres
TOTAL	2,070,183 ACRES

Data Source - WISCLAND (1994)



The Yellow River Area

The Yellow River is a 99-mile warm water stream that originates in Clark County, Wisconsin, and flows through Wood and Juneau Counties before emptying into the Castle Rock Flowage. The Wisconsin Department of Natural Resources (DNR) selected the upper Yellow River as a Priority Watershed in 1990. The Refuge and the DNR proposed a collaborative effort to protect the Yellow River in 1994, with the DNR protection the upper Yellow River and reaches below the Necedah dam.

The Yellow River drains a portion of extinct Glacial Lake Wisconsin which covered much of Central Wisconsin 10,000-12,000 years ago from approximately the current Black River on the west and the current channel of the Wisconsin River on the east. The Yellow River watershed is characterized by near level terrain and sandy soils, as is much of the Central Sands Ecological Landscape. This landscape historically was characterized by pine and oak barrens, wetlands, and dry to dry-mesic oak and pine forests. Currently the Yellow River is a meandering, low-gradient stream with many oxbow lakes, cut-off and running sloughs, and small ponds in the floodplain. The predominant plant community is floodplain forest (silver maple, green ash, swamp white oak, and river birch). Low sandy ridges support white oak, bur oak, shagbark hickory, black cherry, and white pine. Above all, the Yellow River boasts a rich and bountiful bottomland hardwood forest that has retained much of its wild character.

Many rare, uncommon, and declining animal species have been found in the Yellow River area in recent years. Many of these are sensitive to size, isolation, and quality of habitat. Species of Federal concern include the eastern massasauga rattlesnake, Blanding's turtle, and cerulean warbler. The Red-shouldered hawk, Acadian flycatcher, yellow-crowned night heron, sedge wren, prothonotary warbler, and Louisiana waterthrush, each which falls within various state categories of concern, are found there also. An active great blue heron rookery has been present since 1991. Other bird species present during the breeding season include several neotropical migrants which have shown significant population declines. These include the veery, wood thrush, and golden-winged warbler. Waterfowl include the mallard, wood duck, and hooded merganser. Woodcock, wild turkey, ruffed grouse, white-tailed deer, fox squirrel, and grey squirrel are common throughout much of the area.

Currently there are at least six KBB sites in the Yellow River Focus Area. Friendship and Plainfield sands soils, which support necessary habitat for the endangered Karner blue butterfly are found throughout the area. Those soil types offer potential restoration of oak savanna, habitat important to the butterfly. Table 9 is a summary of land cover types found in the Yellow River Focus Area.



TABLE 9 Land Cover Types in the Yellow River Focus Area	
Land Cover Type	Acres
Open Landscapes (grasslands, savanna, shrublands, old fields)	2,593 acres
Coniferous Forests	483 acres
Mixed Deciduous and Coniferous Forests	1,329 acres
Broad-leaf Deciduous Forests	3,909 acres
Emergent Wetlands and Wet Meadows	1,847 acres
Forested Wetlands	10,259 acres
Lowland Shrubs	1,485 acres
Open Water Areas	45 acres
TOTAL	21,953 ACRES

Data Source - WISCLAND (1994)

2.4 Geology

The Refuge lies along the northeastern edge the Wisconsin Driftless Area. The topography of the Refuge is therefore not the result of glaciation, but of erosion and the inundation by Glacial Lake Wisconsin. The topography of the area is extremely flat with a few interspersed sandstone buttes and mesas which are outstanding landmarks in contrast to the general flatness of the terrain. The Refuge is underlain by a Precambrian Crystalline bedrock complex, the surface of which varies in elevation from approximately 860 Mean Sea Level at the north end of the Refuge to approximately 760 M.S.L. at the south end. The Precambrian bedrock is overlain by an estimated 30 to 100 feet stratum of late Cambrian sandstone.

Soils on and around the Refuge represent three major soil associations consistent with central Wisconsin landscapes: Aus Gres loamy sands and Morocco silt loams, Plainfield and Nekoosa loamy sands, and muck and peat soils (see Figure 10 in the CCP). The dominant soil association is the Plainfield and Nekoosa loamy sands. Newson and Dawson peat soils are found in the impoundments, along drainage ditches, and in marshes. These soils are usually inundated and consist of partially decayed organic matter and mineral soils.



3. DESCRIPTION OF THE BIOLOGICAL ENVIRONMENT

3.1 Listed Species

As stated in Chapter 2, Federally listed threatened or endangered species that utilize the Refuge and the adjacent Yellow River area include the bald eagle, eastern timber wolf, and Karner blue butterfly. The Yellow River Focus Area also supports the eastern massasauga rattlesnake, which is a candidate for federal listing.

State-listed threatened or endangered species that use the Refuge include the bald eagle, red-shouldered hawk, Blanding's turtle, eastern massasauga rattlesnake, and trumpeter swan. The Refuge also supports several state-listed species of plants. These include the prairie fameflower, small skullcap, oval-leaved milkweed, and wooly milkweed.

Bald Eagle

The bald eagle, America's national symbol, experienced a drastic decline throughout the country from the 1950s into the early 1970s. This decline was caused by the bio-accumulation of organochlorine pesticides (DDT and dieldrin) in fish and habitat destruction. The use of pesticides which contained DDT or dieldrin were banned in 1972, and shortly there after the number of successful eagle nests increased steadily. Bald eagles were listed as an endangered species in 1976. Due to successful conservation efforts, the bald eagle was recently upgrade to a threatened species. One occupied eagle nest currently occurs at the Refuge.

Eastern Timber Wolf

Eastern timber wolves lived throughout Wisconsin prior to the 1830s. As settlers transformed native habitat into farmland, prey species declined and wolves began feeding on livestock. In 1865, the Wisconsin Legislature paid a \$5.00 state bounty for every wolf killed. The wolf bounty was later increased to \$20.00 for adults and \$10.00 for pups to protect the dwindling deer herd. By 1960, few wolves remained throughout the lower 48 states and were declared extirpated from the State of Wisconsin.

In 1973, the wolf was listed as a federal endangered species and as a state endangered species in the state of Wisconsin in 1975. Between 1979-1986, studies showed that four to six wolf packs (15-25 animals) roamed two areas of northern Wisconsin. Since this period, wolf packs continue to increase throughout Wisconsin. Currently there are at least 66 confirmed wolf packs (248-259 animals) territories in northwestern and central Wisconsin and 11 established wolf packs in the central Wisconsin forest complex (Wydeven et al. 2000). Territories of four packs, Suk Cearney, Yellow River, Dead Creek, and South Bluff, may extend onto the Refuge. The Suk Cearney pack's territory appears to be concentrated on the southern end of the Refuge. This pack has numbered as many as seven individuals at one time. Based on winter wolf track surveys, there may be two dens and/or rendezvous sites on the Refuge, although howling surveys have not detected wolf pups as of yet. For the most recent map of wolf pack distribution in Wisconsin, see the Wisconsin Department of Natural Resources website at:

http://www.dnr.state.wi.us/org/land/er/publications/wolf_progress_reports/00wolfprogress/map99-00.gif.

**Karner Blue Butterfly**

Karner blue butterflies (KBB) have undoubtedly been long time residence of the Refuge property. As previously mentioned,, savanna habitat was present on Refuge land at the time of the original land surveys. KBBs most likely occurred on these savannas. However, definitive proof is lacking. KBBs undoubtedly benefitted from the drainage and expanded burning that occurred at the beginning of the 20th Century. Presently, KBBs are known to occur in 12 population complexes within the Refuge (see Table 10), which constitutes the world's largest remaining population of Karner blue butterflies. The KBB was listed as an endangered species in 1993.

TABLE 10
Karner Blue Butterfly Population Levels
Necedah National Wildlife Refuge (1993-2000)

Complex Name	Size acres	Ref. #	Year							
			1993	1994	1995	1996	1997	1998	1999	2000
South Rynearson	19.5	1	685	682	353	1,361	1,482	155	345	719
North Rynearson	14.3	5	211	314	838	521	179	0	0	146
Old Barrens	15.3	6	N/A	299	624	519	84	26	104	0
Goose Pool	27.4	9	160	215	501	865	282	1,249	3,861	1,952
East Sprague	27.9	10	278	536	1,263	3,896	993	669	844	955
East Rynearson	47.4	2	359	199	105	157	131	310	115	35
Cranberry Loop	28.9	4	N/A	N/A	N/A	N/A	N/A	N/A	298	153
Research/ Natural Area	13.6	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
Clauson Burn	5.3	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
Pool 19	35.8	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	660
Middle Refuge	21.5	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	171

*All population estimates are derived from Pollard-Yates surveys. The software "Distance" was then used to convert survey results to population estimates.



Eastern Massasauga Rattlesnake

Eastern massasauga rattlesnakes have already disappeared from most of Wisconsin. Once widespread and plentiful in southern and western Wisconsin, the eastern massasauga has been reduced to just five populations in the state. One of those populations is located next to the Refuge in the Yellow River. The Yellow River was long considered Wisconsin's best massasauga population in terms of the species abundance. Evidence of this is found in bounty records which indicate that bounty was paid on over 4,000 massasaugas between 1952 and 1972.

The Refuge is thought to harbor eastern massasauga rattlesnakes on its eastern edge, the side of the Refuge that borders the Yellow River. Two snakes were located during the 1990s and both were using sedge meadows east of Highway 80. One of the snakes, a male, had been fitted with a radio transmitter a year earlier on the Yellow River. During 1996 he made the trip from the bottoms of the Yellow River to the Refuge (over a mile one-way) and back. The other snake, a sub-adult, was found near the Refuge in 1993.

The Yellow River population produced 25 eastern massasauga rattlesnakes in the 1990s. Nineteen of these snakes were neonates from two different clutches. Of the six adults, three were located during routine surveys and three were road-killed animals. No new snakes have been located in the Yellow River since 1995, despite intensive survey effort by the Refuge and Wisconsin Department of Natural Resources. The eastern massasauga was listed as a state endangered species in 1975.

The Refuge is currently working with landowners on the Yellow River to conserve snakes through habitat improvements. Similar efforts are under way with landowners around three other massasauga populations. These populations are in LaCrosse, Monroe, and Buffalo counties. The Refuge is developing Candidate Conservation Agreements with landowners on all of these areas.

Whooping Crane

Whooping crane chicks were introduced at the Refuge in the summer of 2001 as part of a whooping crane reintroduction project to establish a migratory population in the eastern U.S. to contribute toward recovery of the species. The population has been designated as a non-essential population (NEP) in a rule making action finalized on June 26, 2001. The crane chicks are being rearing in a pen situation and trained to follow ultra light aircraft in migration to a selected wintering site at Chassahowitzka National Wildlife Refuge. Annual whooping crane introduction, rearing, and release activities are expected to continue for a period of 10 years.

Rare Plants

There may be rare species of plants that have not been identified on the Refuge, particularly those that may be living in remote locations. While several studies have been done on plant abundance and distribution, a comprehensive inventory of Refuge plants is needed. The Refuge and the Yellow River area have populations of several rare and declining plant species (or provide habitat that would support these species) that are described in Table 11.



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TABLE 11
Rare Plants found on the Refuge and within the Yellow River area

Common Name	Scientific Name	State Status*	Habitat/Location
Round-stemmed false foxglove	<i>Agalinus gattingeri</i>	State threatened (Federal status assessment in progress)	Southern Juneau County in dry prairies and bedrock glades
Woolly milkweed	<i>Asclepias languinosa</i>	State threatened	Dry savannas (oak barrens) in Juneau County, just south of Necedah Refuge
Brittle prickly pear	<i>Opuntia fragilis</i>	State threatened	Dry, sandy habitats in neighboring Adams County; may occur in similar habitats in Juneau County
Dwarf bilberry	<i>Vaccinium cespitosum</i>	State endangered	Sandy pine and oak savanna habitats, bracken grasslands
Sand violet	<i>Viola fimbriolata</i>	State endangered	Sandy pine and oak savanna habitats
Pale false foxglove	<i>Agalinus skinneriana</i>	State endangered	Dry savannas in Adams County
Tubercled or pale green orchid	<i>Plantanthera flava</i> var. <i>herbiola</i>	State threatened	Wet prairies and sedge meadows in Juneau and Adams counties
Umbrella sedge	<i>Fuirena pumila</i>	State endangered	Coastal plain species that inhabit peat and muck flats, wet sands, and fluctuating lakeshores
Bald rush	<i>Psilocarya scirpoides</i>	State threatened	Coastal plain species that inhabit peat and muck flats, wet sands, and fluctuating lakeshores
Netted nut-rush	<i>Scleria reticularis</i>	State endangered	Coastal plain species requiring recently desiccated mud or sand lake beds with fluctuating water
Bog bluegrass	<i>Poa paludigena</i>	State threatened	Sedge meadows and tamarack bogs; has been documented in western Adams County.
Beak grass	<i>Diarrhena americana</i>	State endangered	Floodplain forest; may inhabit Yellow River bottoms, adjacent and east of Necedah Refuge

*There are no federally listed plants that are likely to occur on the Refuge.



3.2 Waterfowl and Other Migratory Birds

For centuries, birds have descended upon the Refuge area during their annual migrations between Central and South America and their northern U.S., Canadian, and Arctic breeding grounds. In total, more than 230 different species of birds have been observed on the Refuge since its inception. The Refuge has long been considered an important migratory stopover area for mallards, blue-winged teal, ring-necks, and wood ducks. Other migrant species that utilize the Refuge during spring, summer, or fall include: Canada, snow, and white-fronted geese; sandhill cranes; woodcock; snipe; great blue herons; swans; egrets; dickcissels; warblers; brown thrashers; several different species of sparrows; meadowlarks; sora rails; black-crowned night herons; bobolinks; bitterns; red-headed woodpeckers; and red-tailed hawks; just to name a few. During migrations, three species of geese, 10 species of dabbling ducks, nine species of diving ducks, and trumpeter and tundra swans are commonly found in significant numbers on the Refuge. Waterfowl are most abundant in the fall, with fall counts of ducks averaging around 20,000. Resident bird species include wild turkeys, ruffed grouse, sharp-tailed grouse, woodpeckers, and nuthatches.

In 1999, the Great Lakes-Big Rivers Region of the Service initiated a process to identify its top species priorities in terms of those in need of the greatest conservation attention in the Region. Table 11 is a list of regional priority species that occur on the Refuge and/or the Yellow River Focus Area. In addition, the Refuge and the adjacent Yellow River area contain habitat that supports or historically supported several species of birds on the Service's List of Migratory Nongame Birds of Management Concern. Table 12 contains those species as well.

TABLE 12 Region 3 Fish and Wildlife Resource Conservation Priorities and Migratory Nongame Birds of Management Concern that occur on the Refuge and/or within the Yellow River Focus Area							
Priority Species or Population Bird species in BOLD indicate Migratory Nongame Birds of Management Concern	Regional Status E = Endangered T = Threatened N = Nuisance TT = Tribal Trust R/E = Recreation/ Economic Value	Occurrence on Refuge A = Abundant C = Common U = Uncommon O = Occasional R = Rare				Current or Potential Habitat Supplied by the Refuge and/or the Yellow River Focus Area	
		Spring	Summer	Fall	Winter		
Mammals							
Eastern timber wolf <i>Canis lupus</i>	Federally Endangered	O	O	O	O	Forests	
Birds							
Double-crested cormorant <i>Phalacrocorax auritus</i>	Nuisance	R	R	R	R	Riverine wetlands, upland forests	



TABLE 12 Region 3 Fish and Wildlife Resource Conservation Priorities and Migratory Nongame Birds of Management Concern that occur on the Refuge and/or within the Yellow River Focus Area						
Priority Species or Population Bird species in BOLD indicate Migratory Nongame Birds of Management Concern	Regional Status E = Endangered T = Threatened N = Nuisance TT = Tribal Trust R/E = Recreation/ Economic Value	Occurrence on Refuge A = Abundant C = Common U = Uncommon O = Occasional R = Rare				Current or Potential Habitat Supplied by the Refuge and/or the Yellow River Focus Area
		Spring	Summer	Fall	Winter	
American bittern <i>Botaurus lentiginosus</i>	Rare/declining	U	U	U		Palustrine wetlands, grasslands
Least bittern <i>Ixobrychus exilis</i>	Rare/declining	R	R	R		Palustrine Wetlands
Giant Canada goose <i>Branta canadensis</i>	Recreational and economic value	C	C	A		Lacustrine, Palustrine Wetlands
Trumpeter swan <i>Cygnus bicolor</i>	Rare/declining, Recreational and economic value	U	U	U		Lacustrine, Palustrine, Riverine Wetlands
Wood duck <i>Aix sponsa</i>	Recreational and economic value	C	U	C		Palustrine, riverine wetlands, mature bottomland forests
Mallard <i>Anas platyrhynchos</i>	Recreational and economic value	C	C	A	U	Palustrine wetlands, grasslands, mature bottomland forests
Blue-winged teal <i>Anas discors</i>	Recreational and economic value	C	C	C		Palustrine wetlands, grasslands
Canvasback <i>Aythya valisineria</i>	Recreational and economic value	U	C	U		Lacustrine, Palustrine, Riverine Wetlands
Bald eagle <i>Haliaeetus leucocephalus</i>	Federally threatened, Tribal trust	U	U	U		Lacustrine, Palustrine Wetlands, Forests
Northern goshawk <i>Accipiter gentilia</i>	Rare/declining	O	O	O	O	Forests (mature upland)
Red-shouldered hawk <i>Buteo lineatus</i>	Rare/declining	U	O	U		Forests (mature upland and bottomland)
American woodcock <i>Scolopax minor</i>	Rare/declining	C	C	C		Palustrine Wetlands (wet meadow and shrub/scrub), Forests (early successional)
Black tern <i>Chilodonias niger</i>	Rare/declining	U	U	R		Lacustrine, Palustrine Wetlands
Sedge wren <i>Cistothorus platensis</i>	Rare/declining	U	U	U		Palustrine Wetlands (wet meadows)



TABLE 12 Region 3 Fish and Wildlife Resource Conservation Priorities and Migratory Nongame Birds of Management Concern that occur on the Refuge and/or within the Yellow River Focus Area						
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		Spring	Summer	Fall	Winter	
Cerulean warbler <i>Dendroica cerulea</i>	Rare/declining	R	R			Forests (mature upland and bottomland)
Grasshopper sparrow <i>Ammodramus savannarum</i>	Rare/declining	R	R			Open Landscapes
Henslow’s sparrow <i>Ammodramus henslowii</i>	Rare/declining	R	R			Open Landscapes
Dickcissel <i>Spiza americana</i>	Rare/declining	R	R	R		Open Landscapes
Eastern meadowlark <i>Sturnella magna</i>	Rare/declining	U	U	U		Open Landscapes
Bobolink <i>Dolichonyz oryzivorus</i>	Rare/declining	U	U	U		Open Landscapes
Common Loon <i>(Gavia immer)</i>	Rare/declining	U	O	O		Lacustrine Wetlands
Northern Harrier <i>(Corcus cyaneus)</i>	Rare/declining	C	C	C	R	Open Landscapes
Upland Sandpiper <i>(Bartramia longicauda)</i>	Rare/declining	O	O			Open Landscapes
Yellow-billed cuckoo <i>(Coccyzus americanus)</i>	Rare/declining	O	O			Mature Forests (upland and bottomland)
Short-eared owl <i>(Asio flammeus)</i>	Rare/declining	R		R	R	Open Landscapes
Red-headed woodpecker <i>(Melanerpes erythrocephalus)</i>	Rare/declining	C	C	C	O	Forests (deciduous), Open Landscapes
Northern Flicker <i>(Colaptes auratus)</i>	Rare/declining	A	C	A		Forests (deciduous), Open Landscapes
Olive-sided flycatcher (Contopus cooperi)	Rare/declining	R		R		Forests (early successional)



TABLE 12						
Region 3 Fish and Wildlife Resource Conservation Priorities and Migratory Nongame Birds of Management Concern that occur on the Refuge and/or within the Yellow River Focus Area						
Priority Species or Population	Regional Status	Occurrence on Refuge				Current or Potential Habitat Supplied by the Refuge and/or the Yellow River Focus Area
		Spring	Summer	Fall	Winter	
Bird species in BOLD indicate Migratory Nongame Birds of Management Concern	E = Endangered T = Threatened N = Nuisance TT = Tribal Trust R/E = Recreation/ Economic Value					
Verry <i>(Catharus fuscens)</i>	Rare/declining	C	C	O		Forests (bottomland)
Blue-winged warbler <i>(Vermivora pinus)</i>	Recreational and economic value	O	O	O		Forests (early successional), Open Landscapes
Chesnut-sided warbler <i>(Helmitheros vermivorus)</i>	Rare/declining	U	U	U		Forests (deciduous)
Field sparrow <i>(Spizella pusilla)</i>	Rare/declining	C	C	C		Open Landscapes
Insects						
Karner Blue Butterfly <i>Lycaeides melissa samuelis</i>	Federally endangered	O	C	O		Deciduous forests, savannas
Reptiles						
Eastern massasauga <i>Sistrurus catenatus</i> <i>catenatus</i>	Rare/declining	R	R	R		Wet meadows, Forests (bottomland), Open Landscapes
Fish						
Bighead carp <i>Hypophthalmichthys</i> <i>nobilis</i>	Nuisance	C	C	C		Riverine (large rivers)

3.3 Native Biological Diversity

The Keystone Center, 1991, defines biological diversity as the variety of life and its processes including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur. Biological diversity can be considered at a minimum of four levels: *genetic level*, *species level*, *ecosystem level*, and *landscape level*. In order to manage the biological resources at the Refuge, it is necessary for the Refuge to work at the species, ecosystem, and landscape levels. Species are how we typically measure biological diversity and they historically represent the principal focus of wildlife managers.



Species Level Biological Diversity

The Refuge supports an assortment of mammals that contribute to the ecological, economic, and aesthetic value of central Wisconsin. Within the past 3 years, timber wolves are thought to have established two packs on Refuge land. Timber wolves are a top predator that play an important ecological role, as well as provide educational opportunities for Refuge visitors. Black bear and bobcat are also present in low numbers.

White-tailed deer are very abundant and can be seen on the Refuge almost anywhere, and at anytime. Cottontail rabbits; snowshoe hare; gray, red, fox and flying squirrels; woodchucks; raccoon; skunks; red and gray fox; coyotes; muskrat; mink; otter; opossum; weasels; and badger are mid-sized mammals that serve as both predators and prey in Refuge plant and animal communities. Small mammalian residents include meadow voles, white-footed and deer mice, shrews, and moles. These small animals are a primary food source for many larger animals.

Reptiles and amphibians are important Refuge residents. Snake species include hog-nosed snakes, eastern garter snakes, smooth green snakes, northern water snakes, fox snakes, and eastern massasauga rattlesnakes. Five-lined skinks are a species of lizard that call the Refuge home. Painted, softshell, and snapping turtles can be seen in wetland environments; Blanding's turtles are most frequently seen in upland savanna environments. Frog and toad species that inhabit the Refuge include leopard frogs, green frogs, wood frogs, grey tree frogs, spring peepers, and the American toad. Blue-spotted salamanders are fairly common and can be found in dark moist environments, such as under decaying logs or thick leaf litter.

Invertebrates are abundant on the Refuge and play an integral role in maintaining the ecological balance of several Refuge ecosystems. Wisconsin has approximately 20,000 species of insects - far more than any group of animals in the state. The Refuge is home to the world's largest remaining population of the Federally listed Karner blue butterfly and also to the rare Leonard's skipper. Other rare insects that use the Refuge include the phlox moth, frosted elfin butterfly, Persius dusky wing, ringed bog haunter dragonfly, and two species of tiger beetles.

Fish species are also important members of the Refuges biological community. They cycle nutrients in aquatic systems and serve as food sources for a variety of birds and mammals. Although many fish species are at a disadvantage due to the drainage of Refuge pools for waterbird management, many people travel to the Refuge for rewarding year-round fishing opportunities on Refuge pools and ditches. Muskellunge; northern pike; large mouth bass; yellow perch; black crappie; pumpkinseed; black, brown, and yellow bullhead are some common species sought by anglers.

Ecosystem Level Biological Diversity

Ecosystems are defined as the interacting parts of the physical and biological worlds (Ricklefs 1990). There are three ecosystems of primary importance with respect to the Refuge: wetlands, forests, and open landscapes. Descriptions of these ecosystems are provided in Description of the Physical Environments section "Physiography".



Landscape Level Biological Diversity

Landscape is defined as a number of interacting stands or ecosystems repeated in similar form over a kilometer wide area (Forman and Godron 1986). For convenience, we can think of it as a regional view of biological diversity. Until recently, there has been very little work, particularly in the Midwest, to protect biological diversity at the landscape scale.

In order for the Refuge to exist as part of a functioning landscape, the Refuge will have to: 1) protect and restore ecosystems historically occurring in the landscape across a portion of the Refuge area, 2) arrange protected areas so that the arrangement of ecosystems mimics the natural organization, 3) work cooperatively with a broad array of partners to manage public and privately owned land in order to mimic natural processes, e.g., fire, flooding, succession, and providing connectivity to the matrix in which the Refuge occurs.

The Refuge is promoting biological diversity at the species, ecosystem, and landscape level by using different management regimes. For example, locally some savannas are burned often while others haven't been burned in 8 years. Some savannas are mowed while others have never been mowed. The Refuge is contributing to Regional biological diversity by restoring and maintaining rare habitats including sedge meadows and savannas. Nationally, the Refuge is contributing to biological diversity by providing habitat for endangered species.

4. DESCRIPTION OF THE SOCIOECONOMIC ENVIRONMENT

In 1998, the Refuge completed an economic assessment to estimate the regional economic and national social welfare impacts of the Refuge (Appendix IV). **However, some of the data used to generate the economic report is associated with significant uncertainty. As a result, the estimates in the report should be interpreted with uncertainty in mind.** A brief summary of that report follows.

Within the four-county region surrounding the Refuge (Wood, Juneau, Adams, and Monroe counties), agricultural activities constitute an important component of the economy. This sector includes both dairy farms and farms that grow row crops (e.g., sweet corn, potatoes, snap peas). Cranberry production is also important, and is considered a premium crop in that it commands a high price in the market. Cranberry beds, while representing a small percentage of the total land area, are scattered throughout the region. The total acreage of cranberry beds currently in Juneau and Wood counties alone is estimated to be 4,500. Because the region has large tracts of both private and public forest land, the timber industry is important to the economy as well. Wood County is the most populous and the strongest economically of the four counties.

These four counties offer a variety of recreational activities on both public and private land. Along with the Refuge, there are several other public recreation areas. These include Sandhill Wildlife Area, Wood County Wildlife Area, and Meadow Valley Wildlife Area. Other nearby recreational and camping areas include Buckhorn State Park and Wisconsin Dells, which are south of the Refuge. These offer substitute sites and opportunities to the Refuge for hunting, fishing, wildlife viewing, photography, and other recreational activities.



Affected Environment

Commercial activities on the Refuge include timber harvesting and trapping for pelts (although each are done exclusively to support habitat management). Several of the surrounding towns maintain roadways that pass through the Refuge. Funding for road maintenance on Federal property helps supplement the tax base used to fund road projects. The Refuge annual budget (\$750,000 in 1998) supports employee salaries, operation and maintenance, education, and improvement projects such as bridges, dams, and roads.

Some of the more popular commercial and Refuge management economic activities on the Refuge are:

- The annual budget for staff salaries, maintenance, operations, small capital purchases and educational programs was \$750,000 in 1998.
- Each year, sections of the Refuge are selected for timber harvesting to maintain quality habitat for plants and animals. In 1996-97, 3,237 cords of wood were harvested worth \$155,758.
- Trapping is an important management tool used to reduce or prevent damage to Refuge roads, dikes, and water control structures. Trapping may also reduce predation on nesting birds. Trapped species include mink, beaver, muskrat, and raccoon. The annual average value of pelts taken between 1980 and 1995 was \$6,858.
- In addition to maintenance of land by the Refuge, certain roads within the boundary of the Refuge are maintained by the surrounding townships of Necedah, Finley, Cutler, Remington, and Kingston. These townships spend, on average, approximately \$96,000 annually (1996 dollars) for road maintenance, with a large part of this cost for snow removal.

Conclusions drawn from Refuge-dependent commercial and Refuge management economic activities include:

- Refuge spending contributes over \$1 million and approximately 18 jobs to the regional economy.
- Refuge road maintenance and timber harvesting produce similar effects on the regional economy, accounting for approximately \$150,000 each year.
- Furbearer trapping plays a minor role in the overall regional economy, accounting for only \$7,000 of regional output and less than one job.

The Refuge also has an indirect economic impact on the local economy through the many recreational activities it supports. Among these are hunting, fishing, wildlife viewing, berry picking, cross-country skiing, and photography. Although the Refuge charges no entrance fee, individuals that visit the Refuge and participate in these activities purchase a variety of goods and services in the towns surrounding the Refuge (e.g., food, lodging, fuel, equipment), and thus contribute to the regional economy.

Some of the more popular recreational activities on the Refuge are:

- Hunting for both large (white-tailed deer) and small game species (grey, red, and fox squirrel; rabbit; snowshoe hare; ruffed grouse; waterfowl; wild turkey; and raccoon). In 1996, an estimated 10,000 trips were made to the Refuge for the purpose of hunting.
- Fishing on Refuge waters, primarily for northern pike, bullheads, crappie, yellow perch, and sunfish. In 1996, approximately 7,000 trips were made to the Refuge for the purpose of fishing.
- Wildlife viewing accounted for over 106,000 trips to the Refuge in 1996.



Affected Environment

- Blueberry, raspberry, and blackberry picking are popular during the summer season.
- Gathering dead and down wood for recreation and home heating (with \$5 firewood permit) draws many people to the Refuge.

Conclusions drawn from Refuge-dependent recreational activities include:

- Wildlife viewing has the greatest effect on the regional economy, accounting for between \$1.9 million and \$2.3 million of regional output and between 48 and 67 jobs.
- Recreational hunting has the second greatest effect on the regional economy, accounting for \$250,000 and 6.8 jobs.
- Fishing produces the third greatest regional economic effects, accounting for \$220,000 of regional output and 5.9 jobs.